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Extragalactic Radio Jets and Intergalactic Medium II

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Annual Report

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The ROSAT HRI image of NGC 1265 appears to show the predicted X-ray enhancement of the cluster emission from hydrodynamical structures underneath the radio tail of the galaxy.

The usual model for the radio structure of NGC 1265 involves the bending of the jets by the ram-jet pressure of the extragalactic medium (in this case, in the outer parts of the Perseus cluster). Multiple shocks in the jets and the external medium are produced in this process, and NGC 1265 must have a large velocity relative to the gas through which it moves. Anecdotal support for the model has been obtained from the high peculiar velocity of the galaxy, and from morphological evidence in the radio, but no direct proof of the interaction has been possible: it is not clear that NGC 1265 is immersed in the cluster gas, or that the intracluster medium near NGC 1265 is dense enough to cause the bending.

In the HRI image, we see the galaxy clearly, and also some indication of a structure about 15 arcsec long lying under the inner parts of the radio tails. This is just what is predicted if the passage of the galaxy and the jets through the cluster gas causes strong shocks: it supports the usual bending model, and should allow us to measure the density contrast caused by the flow and hence test the model quantitatively.

At present, we are re-coding our X-ray image fitting software, to allow good fits of the HRI structure near the point X-ray source associated with the nucleus of NGC 1265. This is tricky, in view of the strong “shoulders” of the point response function of the HRI, and ROSAT’s difficulties with aspect solution, so that the job is still incomplete. Until the new code is successfully tested, we cannot be sure of the significance of the X-ray structure, and cannot make the quantitative tests that are required.

The BL Lac studies, which are intended to locate the extended “group” scale gas that we previously found around FR I radio galaxies, are unfinished for the same reason.

Here the scientific aim is to test the suggestion that BL Lac objects are “unified” with FR I radio galaxies: i.e, that the only difference between BL Lac objects and FR I radio galaxies is one of orientation. Thus BL

Lac objects are supposed to be viewed from a direction close to the nuclear jet, whose Doppler-boosted emission then dominates the appearance of the object in the radio, optical, and X-ray. FR I galaxies, on the other hand, are supposed to be viewed from a direction outside the nuclear jet, so that the nucleus is faint relative to the outer radio structure, the optical galaxy, and the unbeamed X-ray emission.

Tests of this idea in the past have been based on radio or optical data. However the X-ray properties of BL Lac objects are one of their defining characteristics, so tests based directly on the X-ray properties will be more powerful. Our aim is to use the ROSAT-discovered fact that all FR I radio galaxies are associated with strong X-ray halos on scales characteristic of small-to-medium-sized groups (Worrall and Birkinshaw 1994), and look for these halos around BL Lac objects.

This test is difficult because the halo X-ray emission is of low contrast relative to the unresolved BL Lac object that it contains. This means that the modeling of the HRI point response function must be accurate, even when working with BL Lac objects selected to have unusually low-luminosity X-ray cores (as in our work).

The data that have been delivered clearly show the BL Lac object, and also an extended region near it. But this extended region may be simply the shoulder of the HRI PRF, and we need to complete work on the fitting code to decide whether we have detected the elusive X-ray halo, or whether we are seeing only features in the HRI's PRF.